

YELLOW FEVER AND FISHES.¹

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If it were not for the little fishes, many parts of tropical America would be uninhabitable. This is the excuse I have made, when an excuse was necessary, for devoting all the time I could steal from my family, my students, and my institution to gathering and contemplating the fishes of the rivers and lakes of South America. But pure research no longer needs to apologize, because it has resulted in many cases in unexpected, but lasting, benefits to man.

I was trying to explain the evolution and distribution of the South American fishes to a young manufacturer of veneer fruit boxes. "You must excuse me," he replied, "but that seems like mighty piddling business to me." I have sometimes been inclined to agree with him.

Yellow fever has been prevalent in Panama and Guayaquil, on the coast of Ecuador, almost ever since the places were settled. The French failed in building the Panama Canal on account of the fevers that killed their men. The hospitals were full. It has been reported that to keep ants from crawling up the bed-posts they were set in dishes of water. Later it was found that mosquitoes bred in the dishes of water, and that these mosquitoes carried the fever germs from patients to well persons. The unrestricted breeding of mosquitoes made success impossible.

General Gorgas cleaned out the mosquitoes in Cuba and in Panama. In doing so he not only made the Panama Canal possible, but did far more in demonstrating that the worst pest-holes in the tropics can be made habitable to man of the temperate zone.

Guayaquil was perhaps the worst of all places in South America. Yellow fever always existed and frequently there were outbreaks that closed the port.

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General Gorgas was called to Guayaquil and he started a campaign against the mosquitoes. The yellow-fever mosquito is domestic, living in the huts and houses of men. In many places drinking water is stored in rain barrels. In these the mosquitoes breed. Each family rears its own fever mosquitoes. It would be easy to keep mosquitoes from breeding by covering the water with a film of oil. But the native will have none of it. It was found that a fish in each barrel keeps the water free from mosquitoes and thus prevents the spread of yellow fever if a case is accidentally introduced.

Various fishes were tried at Guayaquil and two were finally selected as best. They are the "huaijas" and the "chalacos" of the Guayaquil fishermen. They are abundant and easily obtained in Guayaquil.

Recently I obtained specimens of both sorts and found that they are old friends, long known to naturalists as *Lebiasina bimaculata*, and as *Dormitator latifrons*. The latter, the "chalacos" of the fishermen, is a chuckle-headed fish, of the family Gobiidæ. It reaches a length of over a foot and lives principally in the mouths of rivers in the area affected by the tide, all the way from Guayaquil to California. It is therefore available to exterminate mosquitoes in barrels all along the fever-infested coast of western tropical America. A close relative, *Dormitator maculatus*, lives in the same sort of places in the West Indies and on the Atlantic side of the tropical mainland.

The "huaijas" (*Lebiasina bimaculata*) should in time become even a much more valuable fever eradicator, because it is adjusted to live in much higher altitudes than the chalacos. I have caught it all the way from sea level to 7,000 feet elevation. It can, therefore, be used in the entire fever belt, for yellow-fever mosquitoes do not reach as high as 7,000 feet. I have caught it in great numbers in the most unlikely places. At present it is known to inhabit only the rivers from Lima, Peru, to the region of Guayaquil. It should be possible to introduce it in all the tropical parts of America. Related species extend as far north as Panama.

I became acquainted with it in Lima and later caught it inland from Paita. About Lima it is known as "liza de agua dulce," or sweet-water mullet. It is used as an aquarium fish in Lima and is

found in the branches of the Rimac near the bank of the river opposite the city and probably in all the pools near Lima. I found great quantities in the foul, knee-deep pools and ponds near Puente Piedra along the railroad between Lima and Ancon, at Chosica, a health resort inland from Lima, and a native caught some very small ones for me at Matucana at an elevation of over 7,000 feet.

At Piura, in northern Peru, where during the dry season the river had been reduced to a few pools, in which the fishes had become concentrated, I caught them in great numbers. A few miles farther south, in the Jequetepeque River, I got them up as high as Lfallan. The only drawback to this species is its tendency to jump out of the barrels in which it is placed.

These are not the only fishes that eat mosquito larvæ. In the cisterns of Guayaquil the "millions" are used. The "millions" are minute fishes that came originally from Trinidad or Barbados. The males and females are very different from each other and these fishes give birth to living young. They are called "millions" because if you put a pair of them in a pool "there will soon be millions of them." They are very plentiful in Barbados and the absence of yellow fever from Barbados is credited to the "millions," which do not give the mosquitoes a chance. The "millions" have been transplanted far and wide and are usually part of every novice's aquarium specimens.

In the United States much has been accomplished in eradicating fever mosquitoes with *Gambusia*, a small fish which eats the larvæ of the mosquito. Mr. S. F. Hildebrand, of the U. S. Bureau of Fisheries, has had charge of this work for the United States Government and has met with very notable success. It seems that there are many fish eradicators of mosquitoes. Different ones are present in different parts of the world. In most places they need some assistance from man to reach the breeding places of the mosquitoes. It is said in Tampico that upon the appearance of a case of yellow fever the Standard Oil Company spent \$3,000 per week to keep the waters oiled to suppress the mosquitoes until a small fish living in the very neighborhood of the plant was put to work and saved all of that expense.

Of all of the fishes, the "liza de agua dulce" of Lima, or the "huaijas," as it is called at Guayaquil, offers the greatest usefulness.

It can easily be caught, it can easily be transported, and will live at any altitude in which the fever mosquitoes are likely to be found.

With the chalacos available to control the mosquitoes along the coast and the huaijas to control them from the coast to several thousand feet, the means are at hand to entirely eradicate fevers from the Pacific slopes of Tropical America.

With the above paper, portions of a letter dated March 27, 1922, were read, from Dr. Henry Hanson, Director General of the "Compañía Sanitaria Contra la Fiebre Amarilla en el Perú." Dr. Hanson reported that he was sending specimens of six species of fishes with which experiments were made in mosquito control. He says in part:

We found two to be very good larvæ destroyers. . . . I think our campaign has demonstrated that using fish is the only rapid method of handling a yellow fever epidemic.

Dr. Hanson further reports that only two of the six species tried proved valuable. They are the fishes known locally as "chalquoque" and "life," pronounced lē-fā.

ADDENDA.

The "chalquoque" is *Lebiasina bimaculata* C. & V., called "liza de agua dulce" in Lima, and is the "huaijas" so successfully used for mosquito work in Guayaquil. It is found everywhere between Lima and Guayaquil, and in the Rio Rimac it is found from sea level to Matucana at over 7,000 feet.

Another member of the genus is found in the Atrato and San Juan basins in Colombia. Species of a very closely related genus, *Piabucina*, are found from Guayaquil north to the Chagres. The species will be considered, several of them figured in a volume on the fishes of northwestern South America now going through the press (*Mem. Carnegie Mus.*, IX., 1922). The species are members of the *Lebiasininae* of the Characidae.

The "life" is *Pygidium punctulatum piuræ* E., recently described by myself from Piura. It is much of a surprise that this species proves to be a mosquito larva eater. It is, as far as known, restricted to northwestern Peru, but a close relative, *P. punctulatum* (C. & V.) is found in the Rio Rimac from the ocean to several thousand feet at least. It is the "bage" of the Rio Rimac. The

name "bagre" is used almost everywhere in Latin America, but is applied to a great variety of different catfish-like fishes. If the "life" of northern Peru shares its habit of eating mosquito larvæ with the rest of the members of the genus *Pygidium*, it is a most important discovery. Various species of *Pygidium* are found in all the mountain streams of South America and a few are found in the hot lowlands of the Amazon Valley. It belongs to a peculiar family of South American catfishes which are called "bagre," "bagrecitos," "capitan," etc. I monographed the family. ("The Pygidiidæ, a family of South American Catfishes," *Mem. Carnegie Mus.*, VII., No. 5, pp. 259-398, Plates XXXVI.-LVI., 1918.)

In Arequipa I caught specimens of another species of "life," *Pygidium quechuorum*, in such numbers that a devout passer-by exclaimed, "It exceeds the miraculous draft of St. Peter!"

The underlying structure of most of the members of the family is the presence of spines on the opercle and interopercle and the presence of two barbels at the end of the maxillary where other catfishes carry but one barbel. The underlying habit is their eel-like movements and their ability to hold an advance, once gained, by means of the spines on the head. They get under and between rocks, eel their way into holes, and can climb vertical walls.

The queerest members of the family live as commensals or parasites in the gill cavities of larger fishes, and some of them have gained an evil reputation and struck terror into the natives of the entire hot country by the reputed habit of entering the urethra of bathers, sometimes requiring operations or causing death.

Of the genus *Pygidium* about 70 species are known. They range from a few millimeters to 390 mm. in length and are found from sea level to at least 12,000 feet. They are abundant in and about Lake Titicaca. I caught them in southern Chili to northern Colombia and Guiana. They are also abundant in the mountain streams of southeastern Brazil. The other four species of fishes tried in northern Peru and sent by Dr. Hanson are:

1. The "bagre." This is *Pimelodella yuncensis* Steindachner confined to the rivers between Pacasmayo and Paita. It may be found as far south as the Rio Santa. It is not found in the Rimac.

It may be found a little farther north than Paita, but it is not found as far north as Guayaquil, where its place is taken by a related species, *Pimelodella elongata* (G.). The genus *Pimelodella* is very widely distributed in South America "from Buenos Aires to Guiana and Venezuela to the base of the Andes; west of the Andes from Peru to the Chagres River to Panama." I published a monograph of the genus ("*Pimelodella and Typhlobagrus*," *Mem. Carnegie Mus., Pittsburgh*, VII., No. 4, pp. 229-258, Plates XXI.-XXXV., 1917) with figures of most of the species. The *Pimelodellas* are small, long-whiskered catfishes and not much is to be expected of their performance as mosquito eradicators.

2. The "tripon" is *Curimatus peruanus* E., a species recently discovered by me at Sullana. As far as known, it occurs only in the Chira River and at Chiclayo, where the yellow-fever commission caught it. I did not get it at Pacasmayo, only a few miles farther south. There are two other species of *Curimatus* in Guayaquil and five more in Colombia.

The genus is very widely distributed in the hot lowlands east of the Andes. The species do not have teeth and nothing is to be expected of them as mosquito larva eaters. They seem to feed on slime. There are 50 or more known species. I reviewed the group of the toothless Characins to which the genus belongs in 1889 (*Annals N. Y. Acad. Sci.*, IV., pp. 1-32, 1889).

3. The "cachuelo" is *Bryconamericus peruanus* (M. & T.), found in all the streams between the Rimac and the Esmeraldas in Ecuador. In the Rimac it occurs from sea level to over 7,000 feet elevation. It should prove a valuable larva eater. A second species of the genus is found at Guayaquil. North of Guayaquil, in Colombia, several other species are abundant. The genus is widely distributed east of the Andes. It is a member of the Tetragonopterinae of the Characidae. Among the Tetragonopterinae there should be many species available for mosquito work.

I found insect remains in the intestines of many of the species, some of which seem to specialize in the insects naturally blown into the river. The entire group of the Tetragonopterinae has been monographed. Most of the species have been figured. Three parts of the

monograph have been issued, the fourth is in press (*Mem. Mus. Comp. Zoölogy*, XLVII., Cambridge, Mass., 1917, 1918, 1921).

4. The "mojarra" is *Aequidens rivulatus* (G.) of the Cichlidæ. The family is abundant from Texas south. There are seventeen different species of the family between Pacasmayo and Panama. Only the present species is found in Peru. I found it very abundant in pools in the river bed at Piura and in the Jequetepeque River. It is a very active fish with the habits and general appearance of some of our North American sunfishes.

Additional specimens of fishes used in Guayaquil in yellow-fever work were received early in June, 1922, from Dr. W. Pareja, Director de Sanidad, Guayaquil.

Part of my letter of June 5, 1922, to Dr. Pareja follows: "I hasten to inform you that the 'millones' are *Acanthophaelus reticulatus* (Peters). These little fishes are native in Barbadoes, Trinidad, and along the coast streams of Guiana and Venezuela. They have been widely distributed for mosquito work.

"The 'chatas' are *Astyanax festæ* (Boulenger). This fish has only been taken in the Chone, Portoviejo and the Guayas basins, all in Ecuador.

"The 'brejas' belong to two species: (a) *Curimatus troscheli* G. is a lowland fish found only in the Guayas basin and reaches a length of 203 mm. (b) *Prochilodus humeralis* G. is similarly confined to the Guayas and reaches 280 mm. Other species of the genus *Prochilodus* called 'boca chica' are found in countless millions in the Atrato and Magdalena rivers of Colombia and all through the east from the ocean to 3,000 feet. They grow to a considerable size (390 mm.) and are dried and sold to the laborers of Colombia for food."

This account may well be closed with an extract from a letter received from Dr. Hanson, mentioned above. It is dated June 9, 1922:

"It appears that the fact that the 'life' is an effective larvæ consumer is well established by the fact that in the Province of Santa we did nothing except distribute fish in all containers, and did not attempt to throw out or filter any of the water which contained great

numbers of *Stegomyia* larvæ. We used the life almost to the exclusion of other fish because it is hardier and does not have the jumping tendencies of the chalouque and other fish. The other fish which we sent up were rather too delicate to suit the conditions with which we had to contend. We found many of them dead on reëxamining the container some days after the first distribution. This did not occur with the life where it had any reasonable care.

“We secured more than 1,000,000 of these fish, 80 per cent. of which were lifes. We have records of the distribution of 857,561 fish.

“Fortunately we feel certain that we have the question of yellow fever completely dominated in Peru and we believe on the entire Pacific coast of South America.”

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